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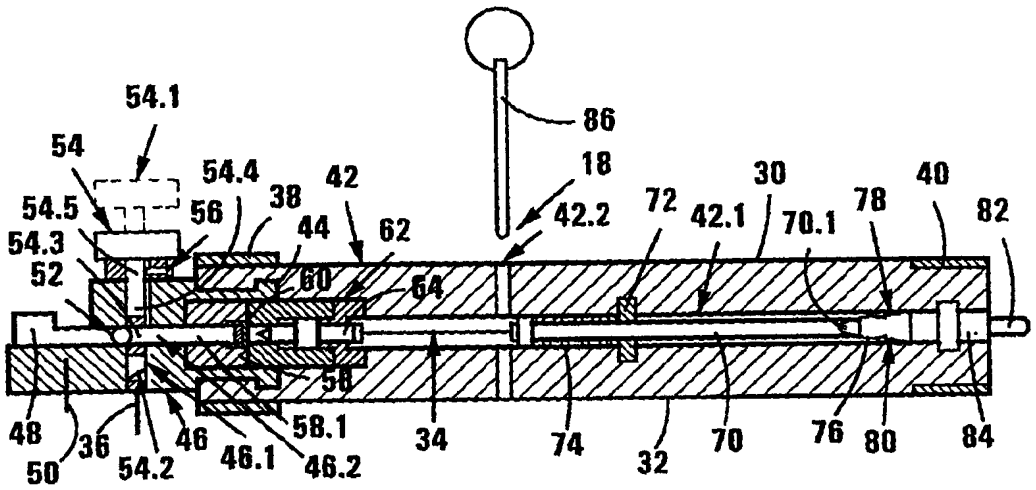
(54) Title: SHOCK TUBE INITIATOR




(57) Abstract

A shock tube initiator (18) includes a detonation component defining a detonation chamber, an initiating passage (58.1) leading out of the chamber, and a shock tube locating formation (46) adjacent the detonation component for locating a portion of shock tube transversely and intersectingly with an open end of the initiating passage. There is a primer charge (60) in the detonation chamber and a firing means (64) for firing the primer charge (60). This invention also relates to a blasting system and methods of initiating shock tubes. The device may comprise a hammer (70) actuated firing pin (64) for firing a small arms blank cartridge (60). Alternatively the device may comprise a hollow, pyrotechnically driven plunger (94), which cuts into the shock tube (92) with its hollow cutting tip (98).

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# SHOCK TUBE INITIATOR

**This invention** relates to the initiation of shock tubes in blasting operations.

The applicant regards present methods known to it for initiating shock tubes as not being reliable.

Accordingly the invention provides a shock tube initiator which includes

a detonation component defining a detonation chamber and an initiating passage leading out of the chamber,

a shock tube locating formation adjacent the detonation component for locating a portion of shock tube transversely and intersectingly with an open end of the initiating passage,

a primer charge in the detonation chamber, and

a firing means for firing the primer charge.

The shock tube initiator may further include a secondary charge in the detonation chamber adjacent the primer charge. The secondary charge may be a body of secondary explosive. An electronic match head may then be used. Those skilled in the art will appreciate that the match head will have an electrically energisable fuse wire and a detonating composition, the fuse wire will then comprise a part of the firing means and the detonating composition will be the primer charge.

Alternatively the shock tube initiator may include a small arms blank cartridge having a percussion cap and a propellant charge. The charge in the percussion cap will then be the primer charge and the propellant charge the secondary charge. With this embodiment the shock tube initiator may include a firing pin and a carrier therefor, displaceable into firing engagement with the cartridge. A hammer displaceable within the detonation chamber into striking engagement with the carrier and an urging means for urging the hammer into striking engagement with the carrier may then also be provided. The urging means may be mechanically or explosively operable. For example, a spring or a propellant charge may be utilised.

If the urging means is mechanically operable, the shock tube initiator may also include a restraining means for holding the hammer in a spaced position away from the carrier, against the urging means. This may be accomplished by an electrically fusible wire.

The shock tube initiator may further include an opening forming means for making an opening in a wall portion of shock tube located in the locating formation. The opening forming means may be manually operable, by a person setting up the blast or it may be automatically operable when the blast occurs. In the latter case, where the initiator has a secondary charge, the secondary charge may operate the opening forming means.

The opening forming means may comprise a notch cutter that is displaceable relative to the locating formation to cut, in use, an opening in the shock tube. The notch cutter may be displaceable in a guide passage in a relatively water tight manner

to impede ingress of moisture into the shock tube. Further, in order to impede ingress of moisture into the shock tube, the locating formation and the notch cutter may be suitably dimensioned to provide a tight fit, in use, between wall material of the shock tube defining the opening therein and the notch cutter to further impede ingress of moisture into the shock tube.

Conveniently, the opening forming means may be a hollow plunger having a cutting tip and being axially displaceable within the initiating passage by means of the secondary charge.

The shock tube initiator may further include a safety arrangement for impeding accidental operation thereof. Conveniently, this may be implemented by a removable safety pin which impedes movement of an appropriate component.

If desired for safety, the notch cutter may have a shoulder or catch to prevent a return stroke after a cutting stoke has been performed.

The invention extends to an initiator as described above in combination with a length of shock tube located in the locating formation thereof.

The invention extends also to a method of initiating shock tube which includes

detonating a secondary charge to provide a shock wave; and

directing the shock wave transversely into the shock tube via an opening formed in the wall thereof.

As indicated above, the secondary charge may be part of a small arms cartridge, in which case the method includes discharging the cartridge by striking a percussion cap thereof with a firing pin.

The firing pin may be struck by a hammer that has been mechanically displaced or by a hammer that has been displaced by mechanically or by a propellant charge.

The method further includes locating a portion of the shock in a locating formation adjacent an initiating passage which communicates with a detonation chamber in which the secondary charge is contained. The opening may then be manually formed or it may be formed automatically when the secondary charge is detonated.

The invention will now be described by way of examples with reference to the accompanying drawings, in which:-

Figure 1 shows schematically a three dimensional view of a set up of explosive charges for blasting a work face;

Figure 2 shows an axial section of a first embodiment of an initiator in accordance with the invention;

Figure 3 shows schematically an axial section of a second embodiment of an initiator in accordance with the invention; and

Figure 4 shows schematically an axial section of a third embodiment of an initiator in accordance with the invention.

Referring to Figure 1 of the drawings, reference numeral 10 indicates generally

a blasting area having a work face 12 into which an array of drill holes 14 have been drilled. The holes 14 have been charged for blasting, and have been interconnected by means of shock tube 16 which is operatively connected to an electrically operable shock tube initiator 18. The initiator 18 is connected via low resistance electrical trigger lines 20 to an exploder 22 at a location remote from the workplace 10. A blast barrier 24, is set up away from the workface 12.

Referring now to Figure 2 of the drawings, the initiator 18 includes two halves of a synthetic plastic moulding 30 and 32 abutting along an equatorial plane 34 at right angles to an axis 36. The two halves 30 and 32 are held together by means of axially spaced rings 38 and 40. The two halves 30 and 32, together form a housing generally indicated by reference numeral 42. At a front end of the housing there is defined a seat 44 which accommodates a shock tube locator 46 having a shock tube grip 48 pivotally mounted thereon about the axis 50. The grip 48 and locator 46 together define a shock tube locating passage 52, shown end on in Figure 2. A shock tube (not shown) is inserted in use, into the passage 52 from the side, when the grip 48 is pivoted out of the way about its axis 50.

Also mounted in the shock tube locator is a notch cutter 54 which is axially displaceable along the axis 36, from its position 54.1 shown dotted in Figure 2, to the position shown in full. When the notch cutter 54 is in the position shown 54.1, then the cutting edge 54.2 is above the passage 52. Once a shock tube is located in the passage 52, then the notch cutter 54 can be displaced from its position 54.1 to its operative position (full lines). In doing so the cutting edge 54.2 will cut a notch opening in a shock tube in position in the passage 52. The notch cutter 54 has a

transverse opening 54.3 which is in alignment with the notch opening cut into the shock tube, when it is in passage 52. A collar 56 has a grubscrew engaging with a longitudinal channel 54.4 in a shank 54.5 to impede rotation of the notch cutter 54 about its axis 36. The collar 56 is secured to the locator 46. The notch cutter shank 54.5 is easily slidable within a passage 46.1, provided in the shock tube locator 46. The locator 46, furthermore has a passage 46.2, which together with a passage 58.1 in a primer charge holder 58, defines a detonation chamber for a blank cartridge 59 having a percussion cap 60 held in a seat in the holder 58.

The holder 58 is co-axially located with a firing pin guide 62 in a bore in the locator 46. A firing pin 64 is axially displaceable within a bore in the firing pin guide 62.

A hammer 70 in the form of a plunger, is guided for axial displacement along the passage 42.1, in the housing 42, by means of the collar 72 located in position transversely to passage 42.1.

A helical compressor spring 74 urges the hammer 70 axially towards the firing pin 64. It is retained in its cocked position shown in Figure 2 of the drawings, by means of a fusible wire 76 engaging with a shoulder 70.1 on the hammer 70. The wire 76 is electrically connected to terminals 78 and 80 which are electrically connected to the connector terminals 82 and 84 of a co-axial connector.

A safety pin 86 is inserted into the passage 42.2, to retain the hammer 70 in its cocked position, prior to positioning the shock tube in the passage 52.

In use, an array of holes will be drilled in the rock face as shown in Figure 1. The holes will be charged with explosives, and will be connected to the shock tube 16. The notch cutter 54 will be displaced to the position 54.1 to permit the insertion of the shock tube 16 into the passage 52 and the shock tube 16 is inserted therein. The grip 48 is pivoted to retain the shock tube in position. The notch cutter 54 is then displaced into its position shown in the solid lines in Figure 2. Thereby the cutting edge 54.2 cuts through the side of the shock tube held in the passage 52 thereby providing a transverse notch opening into the shock tube. In that position, the passage 54.3 which extends transversely through the shank 54.5 of the notch cutter 54 is in register with the passage 58.1 aligned with the percussion cap 60.

Thereafter a co-axial connector is connected to the contacts 82 and 84. The co-axial connector has low resistance conductors leading to the exploder 22.

The fusible wire 76 is chosen to melt under a fairly heavy current flow to ensure that it cannot be subject to tampering. Thus the exploder 22 will apply a voltage of at least 12 volts when it is desired to initiate the explosive charges. The security pin will have been withdrawn from the housing immediately prior to the operation of the exploder 22, from its location remote from the blast face 12. Prior to blasting, a blast barrier 24 will have been placed in position to avoid undue scattering of broken rock.

Referring now to Figure 3 a second embodiment of an initiator in accordance with the invention is designated by reference numeral 90. With this embodiment 90 an opening is formed in a length of shock tube 92 automatically. Thus, this embodiment 90 has a hollow plunger 94 which has a passageway 96 and a cutting

tip 98. The plunger 94 is displaceable within a passage 100 from an initial position into an operating position in which it cuts a notch in the shock tube 92 and in which the passageway 96 communicates with the interior of the shock tube 92 via the notch.

Also located in the passage 100 is a blank cartridge 59 having a percussion cap 60. The cartridge 59 is detonated by a firing pin 64 which is displaced by a secondary propellant charge 104. The secondary charge 104 is initiated by a fuse head 106 having a fuse wire 108 and a primer charge 110. As with the first embodiment 18, this embodiment 90 has a connector 112 by means of which the fuse head 106 is connected to the exploder 22.

In use, when the exploder 22 provides sufficient firing current, the primer charge 110 is initiate and, in turn, initiates the secondary charge 104. As a result thereof the firing pin 64 is displaced and strikes the percussion cap 60 which discharges the cartridge 59. This causes the plunger 94 to move in the passage 100 to cut a notch in the shock tube 92. At the same time an explosive front enters the shock tube 92 via the passageway 96 and initiates the shock tube 96.

A third embodiment of an initiator 114 in accordance with the invention is shown in Figure 4. This embodiment 114 is similar to the embodiment 90 of Figure 3 in that it has the hollow plunger 94 with the cutting tip 98. However, this embodiment has a secondary propellant charge 104 and a match head 116 with a primer charge 118. The secondary charge 104 is such as to drive the plunger 94 through and past the shock tube 92 to align the passageway 96 with the interior of

the shock tube 92 and permit the explosive front to enter the shock tube 92 and initiate it.

## CLAIMS

1. A shock tube initiator which includes

a detonation component defining a detonation chamber and an initiating passage leading out of the chamber;

a shock tube locating formation adjacent the detonation component for locating a portion of shock tube transversely and intersectingly with an open end of the initiating passage;

a primer charge in the detonation chamber; and

a firing means for firing the primer charge.

2. A shock tube initiator as claimed in Claim 1, which includes a secondary charge in the detonation chamber adjacent the primer charge.

3. A shock tube initiator as claimed in Claim 2, which includes a small arms blank cartridge, a percussion cap thereof being the primer charge.

4. A shock tube initiator as claimed in Claim 2, in which the secondary charge comprises a body of secondary explosive.

5. A shock tube initiator as claimed in Claim 4, which includes an electronic match head which has an electrically energisable fuse wire and a detonating composition, the fuse wire comprising a part of the firing means and the detonating composition being the primer charge.

6. A shock tube initiator as claimed in Claim 3, which includes a firing pin and a carrier therefor, displaceable into firing engagement with the cartridge.

7. A shock tube initiator as claimed in Claim 6, which includes a hammer displaceable within the detonation chamber into striking engagement with the carrier; and an urging means for urging the hammer into striking engagement with the carrier.

8. A shock tube initiator as claimed in Claim 7, in which the urging means is mechanically operable.

9. A shock tube initiator as claimed in Claim 8, which includes a restraining means for holding the hammer in a spaced position away from the carrier, against the urging means.

10. A shock tube initiator as claimed in Claim 9, in which the restraining means comprises an electrically fusible wire.

11. A shock tube initiator as claimed in Claim 7, in which the urging means comprises a propellant charge that is initiated by the firing means.

12. A shock tube initiator as claimed in Claim 2, which includes an opening forming means for making an opening in a wall portion of shock tube located in the locating formation.

13. A shock tube initiator as claimed in Claim 12, in which the opening forming means is manually operable.

14. A shock tube initiator as claimed in Claim 12, in which the opening forming means is automatically operable by the secondary charge.

15. A shock tube initiator as claimed in Claim 13, in which the opening forming means comprises a notch cutter that is displaceable relative to the locating formation to cut, in use, an opening in the shock tube.

16. A shock tube initiator as claimed in Claim 15, in which the notch cutter is displaceable in a guide passage in a relatively water tight manner to impede ingress of moisture into the shock tube.

17. A shock tube initiator as claimed in Claim 16, in which there is, in use, a tight fit between wall material of the shock tube defining the opening therein and the notch cutter to impede ingress of moisture into the shock tube.

18. A shock tube initiator as claimed in Claim 14, in which the opening forming means is a hollow plunger having a cutting tip and being axially displaceable within the initiating passage by means of the secondary charge.

19. A shock tube initiator as claimed in Claim 1, which includes a safety arrangement for impeding accidental operation thereof.

20. A shock tube initiator, substantially as described herein with reference to the accompanying drawings.

21. A blasting system which includes a shock tube initiator as claimed in any one of Claims 1 to 20 with a length of shock tube located in the locating formation thereof.

22. A method of initiating shock tube, which includes

detonating a secondary charge to provide a shock wave; and

directing the shock wave transversely into the shock tube via an opening formed in the wall thereof.

23. A method of initiating shock tube as claimed in Claim 22, in which the secondary charge is part of a small arms cartridge.

24. A method of initiating shock tube as claimed in Claim 23, in which the cartridge is discharged by striking a percussion cap thereof with a firing pin.

25. A method of initiating shock tube as claimed in Claim 24, in which the firing pin is struck by a hammer that has been mechanically displaced.

26. A method of initiating shock tube as claimed in Claim 24, in which the firing pin is struck by a hammer that has been displaced by a propellant charge.

27. A method of initiating shock tube as claimed in Claim 22, in which the

secondary charge comprises a body of secondary explosive material.

28. A method of initiating shock tube as claimed in Claim 22, which includes locating a portion of the shock tube in a locating formation adjacent an initiating passage which communicates with a detonation chamber in which the secondary charge is contained.

29. A method of initiating shock tube as claimed in Claim 28, in which the opening is formed manually after it is located in the locating formation.

30. A method of initiating shock tube as claimed in Claim 28, in which the opening is formed automatically when the secondary charge is detonated.

31. A method of initiating shock tube, substantially as described herein, with reference to the accompanying drawings.

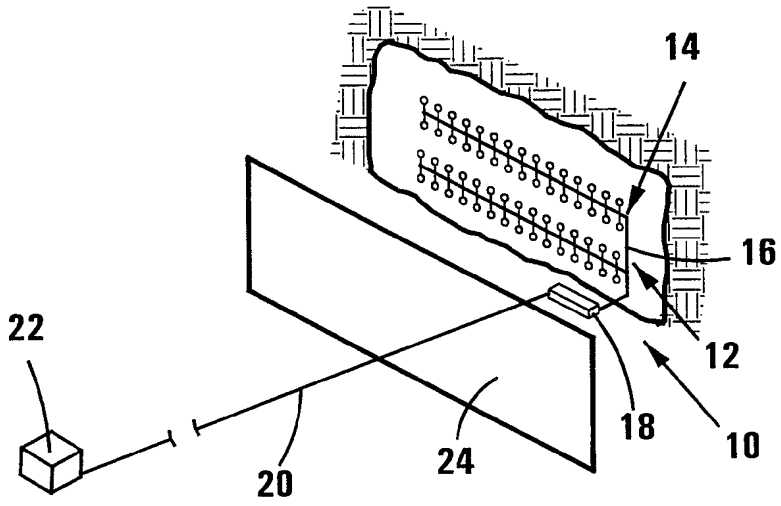
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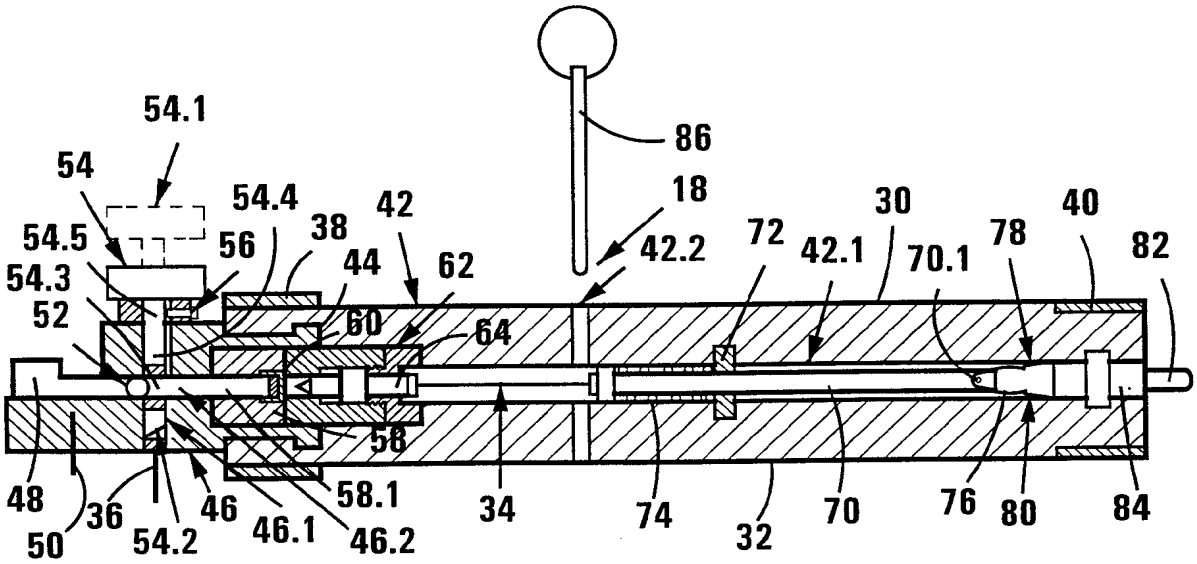
FIG 1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70.1
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FIG 2

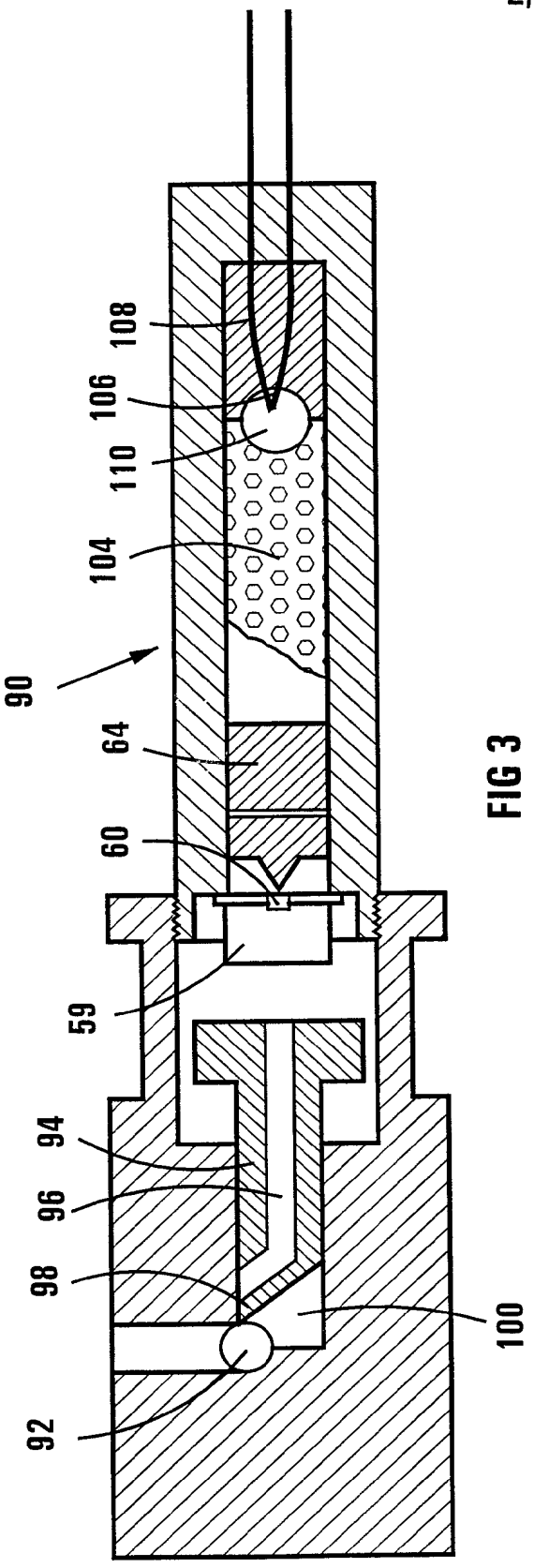


FIG 3

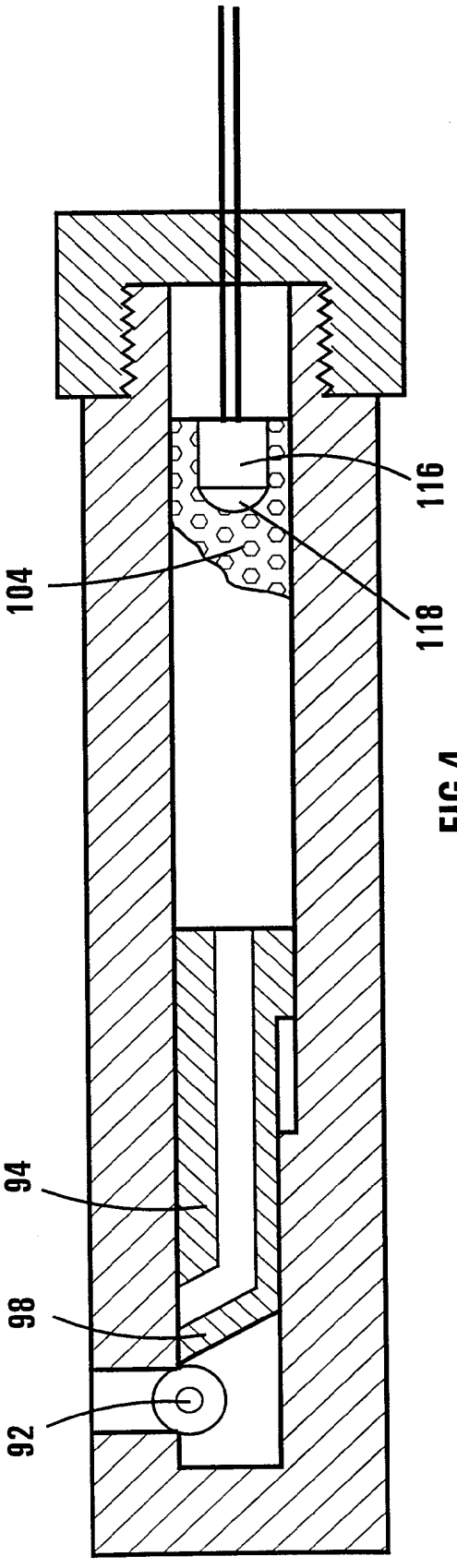


FIG 4

# INTERNATIONAL SEARCH REPORT

Inte onal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F42D1/04

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F42D F42C F42B

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 5 594 196 A (RONTEY ET AL.)<br>14 January 1997 (1997-01-14) | 1,2,4,<br>20-22,<br>27,28,<br>30,31 |
| Y | column 5, line 15 -column 6, line 45;<br>figures 4-6 | 3,5,6,<br>12,13,<br>23,24,29 |
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| | --- | |
| Y | US 5 714 712 A (EWICK ET AL.)<br>3 February 1998 (1998-02-03) | 5 |
| A | column 7, line 61 -column 8, line 17;<br>figure 3A | 1,2,4 |
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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| Y | EP 0 208 416 A (AECI)<br>14 January 1987 (1987-01-14)<br>column 4, line 21 - line 39; figure 6 | 1,12,13,<br>22,29 |
| Y | GB 2 140 137 A (ICI AUSTRALIA)<br>21 November 1984 (1984-11-21)<br>abstract; figure 2 | 1,22 |
| A | GB 705 086 A (CANADIAN INDUSTRIES)<br>page 3, left-hand column, line 38 - line 59; figures 4-6 | 1,2,4,<br>20,22,<br>27,31 |
| A | THOMAS C. JONES: "Underwater Initiator"<br>NAVY TECHNICAL DISCLOSURE BULLETIN,<br>vol. 4, no. 3, March 1979 (1979-03), pages 29-33, XP002127794<br>the whole document | 1,3,6-9,<br>11,<br>19-26,31 |
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Int. ional Application No
PCT/IB 99/01628

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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| A | US 5 144 893 A (ZEMAN ET AL.)<br>8 September 1992 (1992-09-08) | |

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Inte ional Application No
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